Deployment Specification Challenges
in the Context of Large-Scale Systems

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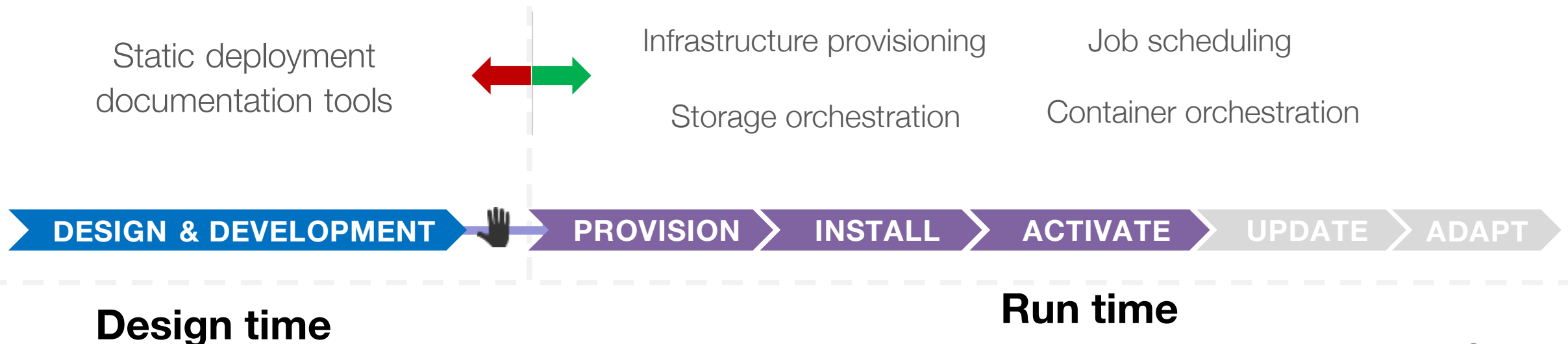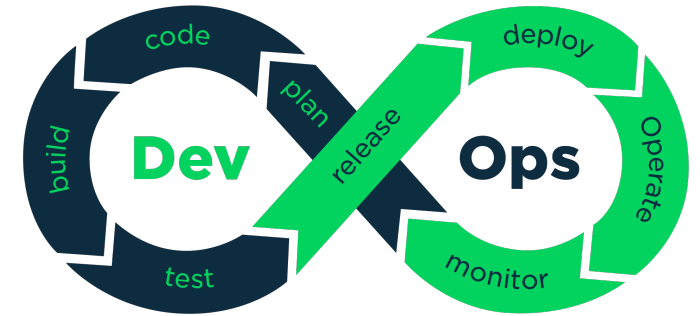
Software Deployment

Focus has been mainly on:

- Infrastructure to realize Deployment & Configuration (D&C)
- Increasing interest on IoT and CPS deployment

Missing:

- Links between design and run time deployment artefacts

Static deployment documentation tools

Infrastructure provisioning

Job scheduling

Storage orchestration

Container orchestration

DESIGN & DEVELOPMENT **PROVISION** **INSTALL** **ACTIVATE** **UPDATE** **ADAPT**

Design time

Run time

2

Smart Transportation

- Multi-tier software architecture
- Cross-cutting dimensions/concerns
- Several interacting apps:
  - Several development teams
  - Different technologies
  - Different governance policies
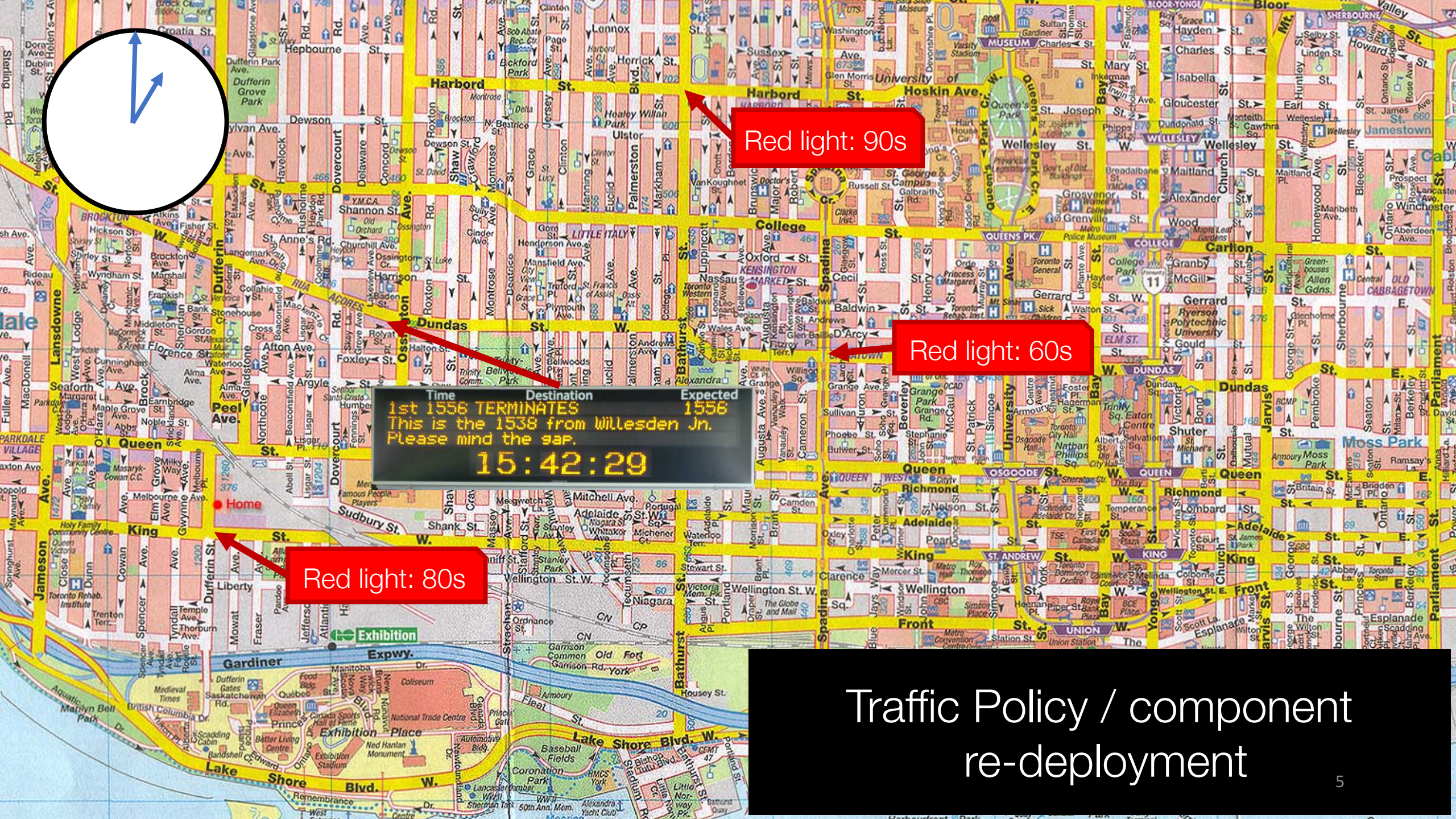- Executive and technical stakeholders

	Information collection	Analysis	Traffic control	Information provision
Data visualisation		Urban network analysis	Real-time traffic assessment	Real-time traffic data (emergence response)
Data mining		Large-scale data processing	Assisted decision making	Traffic reports (planning)
Data sources				Open data (traffic history)
Data storage	Big data storage · Distributed filesystem	NoSQL data storage		
Network communication				
Physical infrastructure	Traffic cameras · Smartphones · Loop detectors	Computing servers	Signal controllers	Information boards & smartphones

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Red light: 80s

Red light: 40s

Red light: 60s

Home

Red light: 90s

Red light: 60s

```
Time        Destination        Expected
1st 1556 TERMINATES                 1556
This is the 1538 from Willesden Jn.
Please mind the gap.

        15:42:29
```

Home

Red light: 80s

Traffic Policy / component re-deployment

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UML Deployment Diagram

Same elements, different configuration

"Database engine"

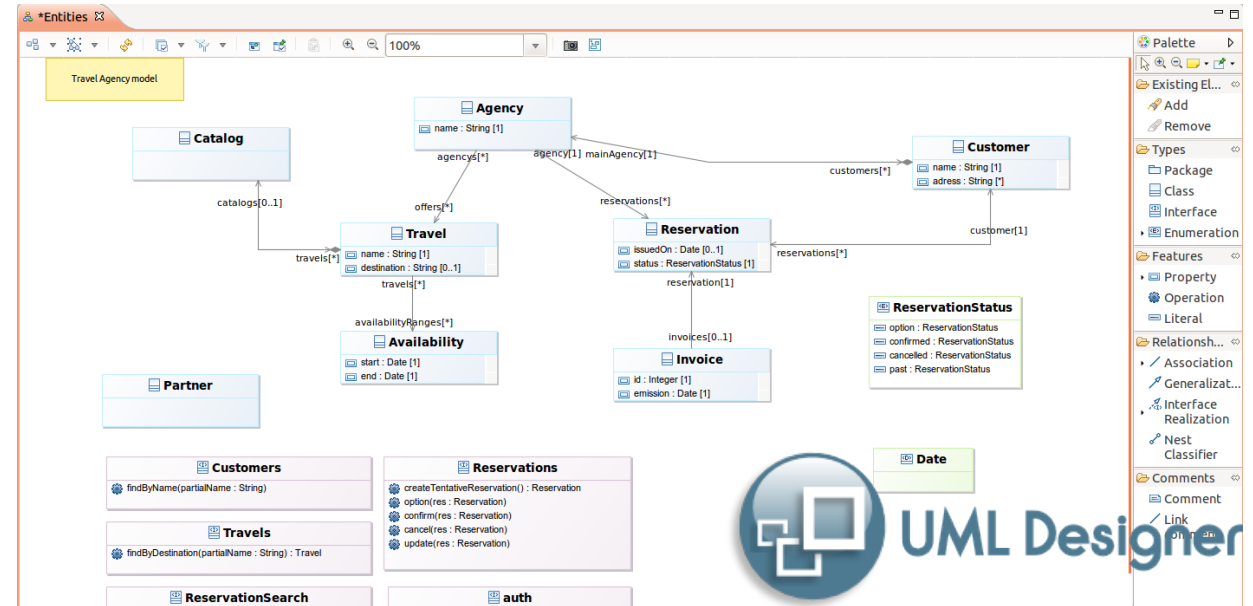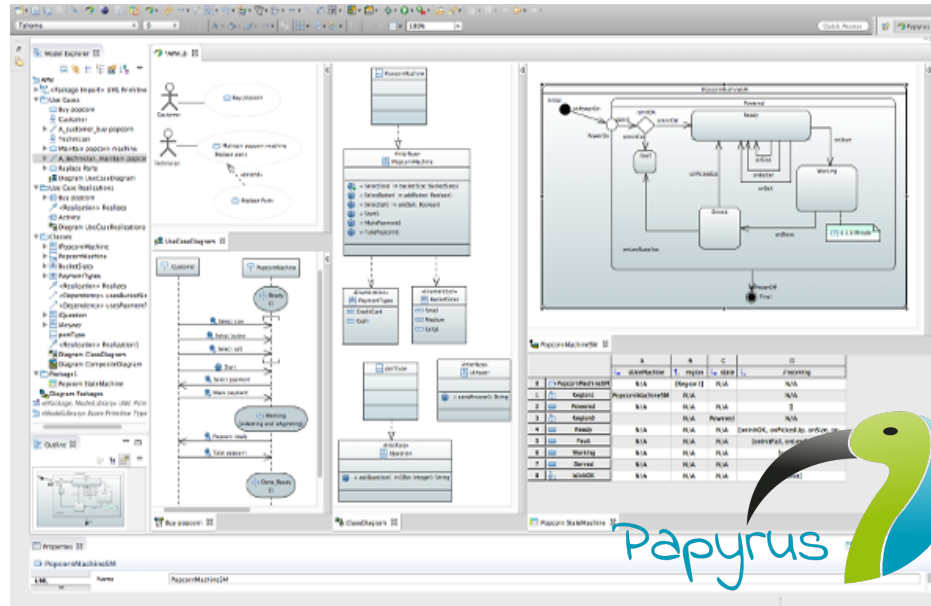"JMeter"
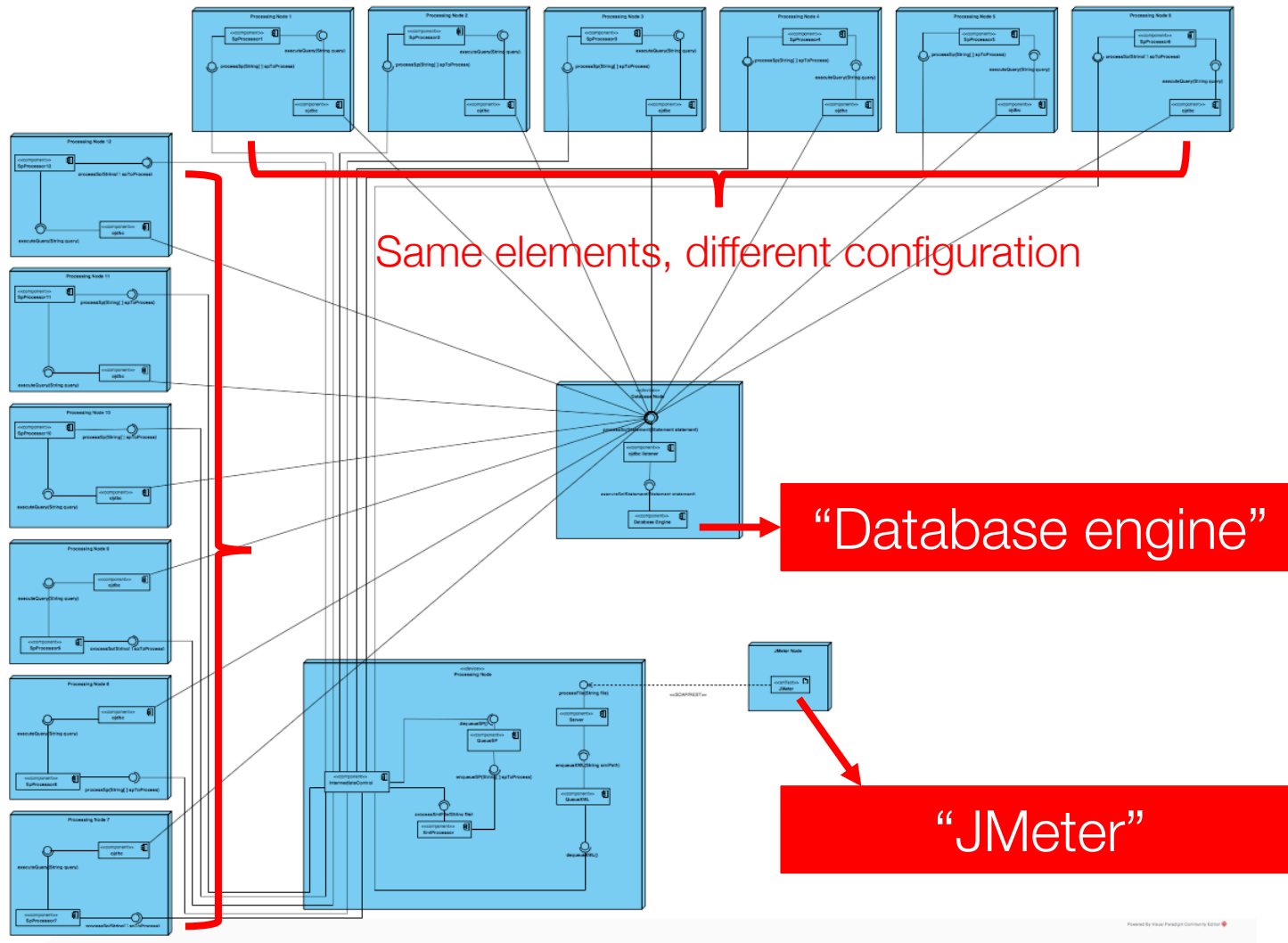
- Static representation
- One of several variations
- Producer/Consumer
- Duplicate elements
- Deployment evolution
- Cloud deployments
- Illustrative components
- Network configuration
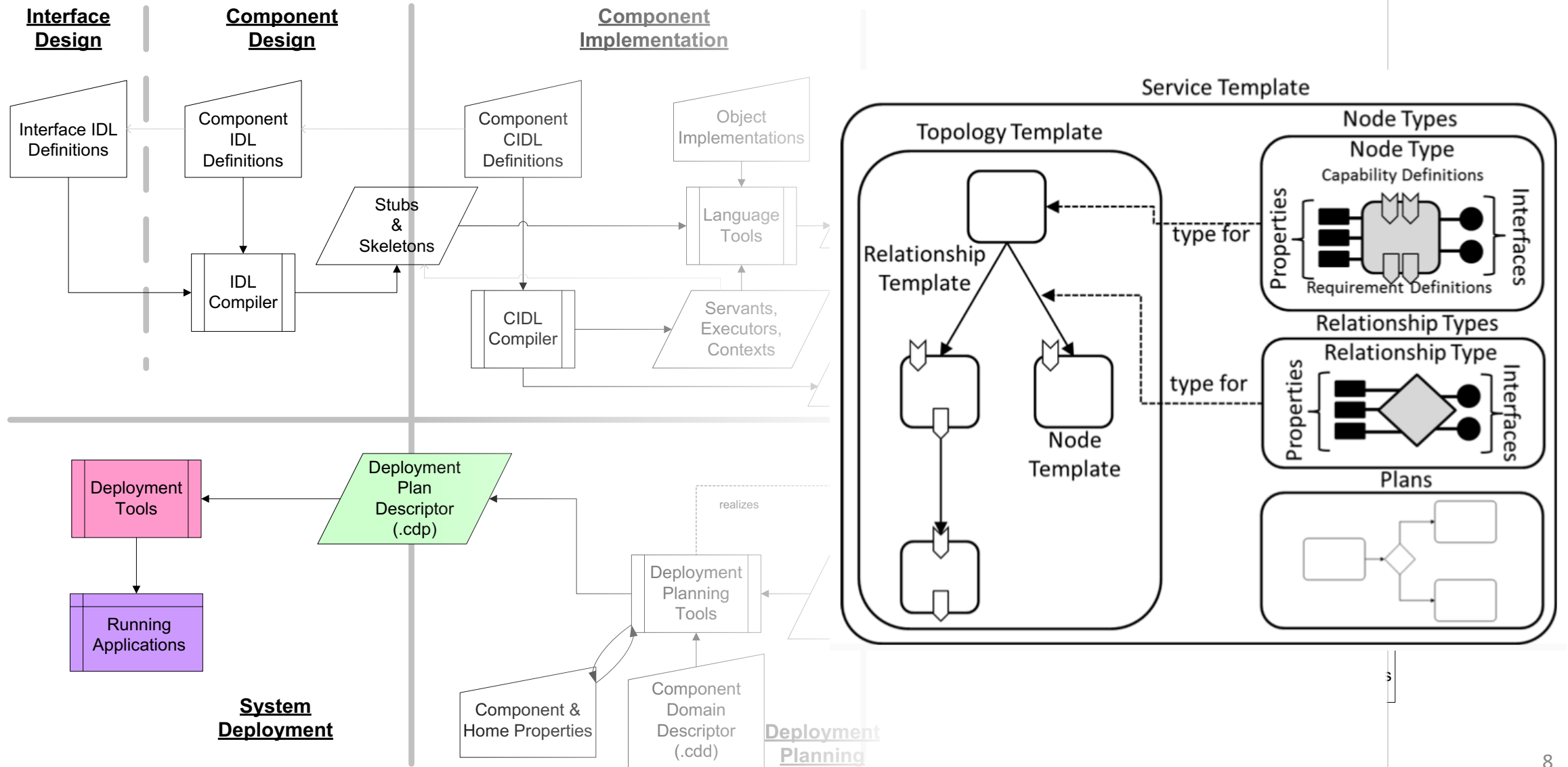- Manual implementation

UML Deployment Diagram (2)

Remaining issues:

- Diagram does not scale up well

- Infrastructure provisioning, network configuration, elasticity?

- Static documentation only

OMG's D&C / OASIS TOSCA Specification
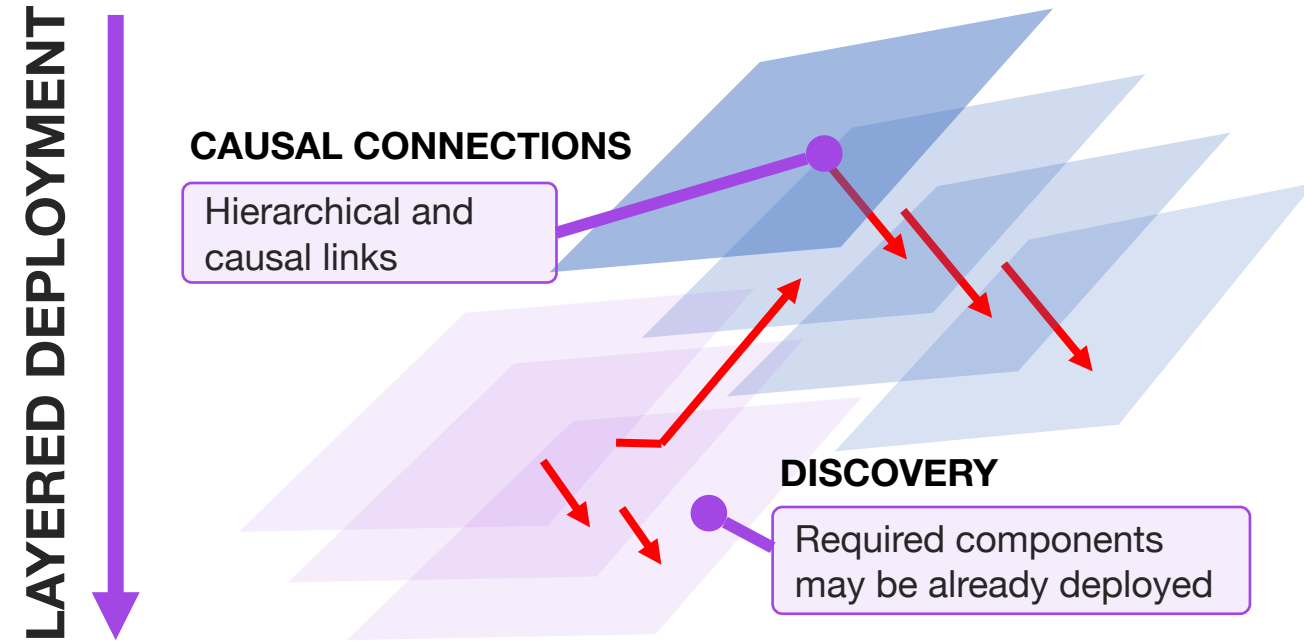
Our Vision

Deployment technology to:

- Reuse specs and automation

- Correspondence between model representations

- Model software deployment at different levels of abstraction

- Execute distributed causally-connected specs-models (change propagation)

LAYERED DEPLOYMENT

CAUSAL CONNECTIONS

Hierarchical and causal links

DISCOVERY

Required components may be already deployed

Deployment Specification Challenges

CH1
Notations for specifying and visualising deployments from different perspectives and levels of abstraction

CH2
Deployment notations to support cross-cutting concerns

CH3
Notation and tool support for linking design and runtime deployment concepts

CH4
Tool support for the evolution of deployment specifications and configuration management at runtime

CH1 Completeness in Deployment Specifications

The UML deployment diagram is one of the **least adopted diagrams** MDE [1], UML users [2]

Stakeholders expect documentation in **different levels of detail and abstraction**

D&C for large-scale systems requires a specification that enables scalability in representation

1. Hutchinson, John, Mark Rouncefield, and Jon Whittle. "Model-driven engineering practices in industry." Proceedings of the 33rd International Conference on Software Engineering. ACM, 2011.

2. Petre, Marian. "UML in practice." Proceedings of the 2013 International Conference on Software Engineering. IEEE Press, 2013.

CH2 Specification of Cross-Cutting Concerns

D&C is shared across design, development, operations, and security

Technical levels of stakeholder proficiency in the development of D&C specifications

- High-level views (architecture) for executive stakeholders, detailed technical views for specialised staff [1]
- One notation may not be enough
- Connection of specifications as well as runtime models that represent them

1. Inzinger, Christian, et al. "MADCAT: A methodology for architecture and deployment of cloud application topologies." Service Oriented System Engineering (SOSE), 2014 IEEE 8th International Symposium on. IEEE, 2014.

CH3 Linking Design and Runtime Deployment Concepts

Mapping between **design and runtime deployment concepts** is not direct anymore

Systematic approaches to maintain the correspondence are rarely used in practice [1]

Causal connections among runtime models: change propagation across different dimensions

1. Nugroho, Ariadi, and Michel RV Chaudron. "A survey of the practice of design--code correspondence amongst professional software engineers." Empirical Software Engineering and Measurement, 2007. ESEM 2007. First International Symposium on. IEEE, 2007.

CH4 Adaptivity and Configuration Management at Runtime

The dynamic nature of the cloud enables architectural agility

Deployment specifications should remain updated automatically

Deployment assessment/simulation

Thank you!

CH1

Notations for specifying and visualising deployments from different perspectives and levels of abstraction

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Notation and tool support for linking design and runtime deployment concepts

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Tool support for the evolution of deployment specifications and configuration management at runtime

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